

Example:

$$\begin{aligned}x_{\text{THC}[\text{NMC-FID}]\text{cor}} &= 10.4 \text{ } \mu\text{mol/mol} \\x_{\text{THC}[\text{THC-FID}]\text{cor}} &= 150.3 \text{ } \mu\text{mol/mol}\end{aligned}$$

$$\begin{aligned}RFPF_{\text{C}_2\text{H}_6[\text{NMC-FID}]} &= 0.019 \\PF_{\text{CH}_4[\text{NMC-FID}]} &= 0.990 \\RF_{\text{CH}_4[\text{THC-FID}]} &= 1.05\end{aligned}$$

$$x_{\text{CH}_4} = \frac{10.4 - 150.3 \cdot 0.019}{0.990 - 0.019 \cdot 1.05}$$

$$x_{\text{CH}_4} = 7.78 \text{ } \mu\text{mol/mol}$$

(2) For a GC-FID,  $x_{\text{CH}_4}$  is the actual dry-to-wet corrected  $\text{CH}_4$  concentration as measured by the analyzer.

[76 FR 57462, Sept. 15, 2011]

**§ 1065.665 THCE and NMHCE determination.**

(a) If you measured an oxygenated hydrocarbon's mass concentration, first calculate its molar concentration in the exhaust sample stream from

which the sample was taken (raw or diluted exhaust), and convert this into a  $\text{C}_1$ -equivalent molar concentration. Add these  $\text{C}_1$ -equivalent molar concentrations to the molar concentration of NOTHC. The result is the molar concentration of THCE. Calculate THCE concentration using the following equations, noting that equation 1065.665-3 is only required if you need to convert your OHC concentration from mass to moles:

$$x_{\text{THCE}} = x_{\text{NOTHC}} + \sum_{i=1}^N (x_{\text{OHC}_i} - x_{\text{OHC}_i\text{-init}}) \quad \text{Eq. 1065.665-1}$$

$$x_{\text{NOTHC}} = x_{\text{THC}[\text{THC-FID}]\text{cor}} - \sum_{i=1}^N (x_{\text{OHC}_i} \cdot RF_{\text{OHC}_i[\text{THC-FID}]}) \quad \text{Eq. 1065.665-2}$$

$$x_{\text{OHC}_i} = \frac{\frac{m_{\text{dexhOHC}_i}}{M_{\text{OHC}_i}}}{\frac{m_{\text{dexh}}}{M_{\text{dexh}}}} = \frac{n_{\text{dexhOHC}_i}}{n_{\text{dexh}}} \quad \text{Eq. 1065.665-3}$$

Where:

$x_{\text{THCE}}$  = The  $\text{C}_1$ -equivalent sum of the concentration of carbon mass contributions of non-oxygenated hydrocarbons, alcohols, and aldehydes.

$x_{\text{NOTHC}}$  = The  $\text{C}_1$ -equivalent sum of the concentration of nonoxygenated THC.

$x_{\text{OHC}_i}$  = The  $\text{C}_1$ -equivalent concentration of oxygenated species  $i$  in diluted exhaust, not corrected for initial contamination.

$x_{\text{OHC}_i\text{-init}}$  = The  $\text{C}_1$ -equivalent concentration of the initial system contamination (optional) of oxygenated species  $i$ , dry-to-wet corrected.

$x_{\text{THC}[\text{THC-FID}]\text{cor}}$  = The  $\text{C}_1$ -equivalent response to NOTHC and all OHC in diluted exhaust, HC

contamination and dry-to-wet corrected, as measured by the THC-FID.

$RF_{\text{OHC}_i[\text{THC-FID}]}$  = The response factor of the FID to species  $i$  relative to propane on a  $\text{C}_1$ -equivalent basis.

$C^\#$  = The mean number of carbon atoms in the particular compound.

$M_{\text{dexh}}$  = The molar mass of diluted exhaust as determined in § 1065.340.

$m_{\text{dexhOHC}_i}$  = The mass of oxygenated species  $i$  in dilute exhaust.

$M_{\text{OHC}_i}$  = The  $\text{C}_1$ -equivalent molecular weight of oxygenated species  $i$ .

$m_{\text{dexh}}$  = The mass of diluted exhaust.

$n_{\text{dexhOHC}_i}$  = The number of moles of oxygenated species  $i$  in total diluted exhaust flow.

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$n_{\text{dexh}}$  = The total diluted exhaust flow.

(b) If we require you to determine NMHCE, use the following equation:

$$x_{\text{NMHCE}} = x_{\text{THCE}} - RF_{\text{CH}_4[\text{THC-FID}]} \cdot x_{\text{CH}_4} \quad \text{Eq. 1065.665-4}$$

Where:

$x_{\text{NMHCE}}$  = The  $\text{C}_1$ -equivalent sum of the concentration of carbon mass contributions of non-oxygenated NMHC, alcohols, and aldehydes.

$RF_{\text{CH}_4[\text{THC-FID}]}$  = response factor of THC-FID to  $\text{CH}_4$ .

$x_{\text{CH}_4}$  = concentration of  $\text{CH}_4$ , HC contamination (optional) and dry-to-wet corrected, as measured by the gas chromatograph FID.

(c) The following example shows how to determine NMHCE emissions based on ethanol ( $\text{C}_2\text{H}_5\text{OH}$ ), methanol ( $\text{CH}_3\text{OH}$ ), acetaldehyde ( $\text{C}_2\text{H}_4\text{O}$ ), and formaldehyde ( $\text{HCHO}$ ) as  $\text{C}_1$ -equivalent molar concentrations:

$$x_{\text{THC}[\text{THC-FID}]\text{cor}} = 145.6 \mu\text{mol/mol}$$

$$x_{\text{CH}_4} = 18.9 \mu\text{mol/mol}$$

$$x_{\text{C}_2\text{H}_5\text{OH}} = 100.8 \mu\text{mol/mol}$$

$$x_{\text{CH}_3\text{OH}} = 1.1 \mu\text{mol/mol}$$

$$x_{\text{C}_2\text{H}_4\text{O}} = 19.1 \mu\text{mol/mol}$$

$$x_{\text{HCHO}} = 1.3 \mu\text{mol/mol}$$

$$RF_{\text{CH}_4[\text{THC-FID}]} = 1.07$$

$$RF_{\text{C}_2\text{H}_5\text{OH}[\text{THC-FID}]} = 0.76$$

$$RF_{\text{CH}_3\text{OH}[\text{THC-FID}]} = 0.74$$

$$RF_{\text{H}_2\text{H}_4\text{O}[\text{THC-FID}]} = 0.50$$

$$RF_{\text{HCHO}[\text{THC-FID}]} = 0.0$$

$$\begin{aligned} x_{\text{NMHCE}} &= x_{\text{THC}[\text{THC-FID}]\text{cor}} - (x_{\text{C}_2\text{H}_5\text{OH}} \cdot \\ &\quad RF_{\text{C}_2\text{H}_5\text{OH}[\text{THC-FID}]} + x_{\text{CH}_3\text{OH}} \cdot \\ &\quad RF_{\text{CH}_3\text{OH}[\text{THC-FID}]} + x_{\text{C}_2\text{H}_4\text{O}} \cdot \\ &\quad RF_{\text{C}_2\text{H}_4\text{O}[\text{THC-FID}]} + x_{\text{HCHO}} \cdot \\ &\quad RF_{\text{HCHO}[\text{THC-FID}]} + x_{\text{C}_2\text{H}_5\text{OH}} + x_{\text{CH}_3\text{OH}} + \\ &\quad x_{\text{C}_2\text{H}_4\text{O}} + x_{\text{HCHO}} - (RF_{\text{CH}_4[\text{THC-FID}]} \cdot x_{\text{CH}_4}) \end{aligned}$$

$$\begin{aligned} x_{\text{NMHCE}} &= 145.6 - (100.8 \cdot 0.76 + 1.1 \cdot 0.74 + \\ &\quad 19.1 \cdot 0.50 + 1.3 \cdot 0) + 100.8 + 1.1 + 19.1 \\ &\quad + 1.3 - (1.07 \cdot 18.9) \end{aligned}$$

$$x_{\text{NMHCE}} = 160.71 \mu\text{mol/mol}$$

[73 FR 37337, June 30, 2008]

### § 1065.667 Dilution air background emission correction.

(a) To determine the mass of background emissions to subtract from a diluted exhaust sample, first determine the total flow of dilution air,  $n_{\text{dil}}$ , over the test interval. This may be a measured quantity or a calculated quantity. Multiply the total flow of dilution air by the mean mole fraction (*i.e.*, concentration) of a background emission. This may be a time-weighted mean or a

flow-weighted mean (*e.g.*, a proportionally sampled background). Finally, multiply by the molar mass,  $M$ , of the associated gaseous emission constituent. The product of  $n_{\text{dil}}$  and the mean molar concentration of a background emission and its molar mass,  $M$ , is the total background emission mass,  $m$ . In the case of PM, where the mean PM concentration is already in units of mass per mole of sample,  $\bar{M}_{\text{PM}}$ , multiply it by the total amount of dilution air flow, and the result is the total background mass of PM,  $m_{\text{PM}}$ . Subtract total background mass from total mass to correct for background emissions.

(b) You may determine the total flow of dilution air by a direct flow measurement.

(c) You may determine the total flow of dilution air by subtracting the calculated raw exhaust molar flow as described in § 1065.655(f) from the measured dilute exhaust flow. This may be done by totaling continuous calculations or by using batch results.

(d) You may determine the total flow of dilution air from the measured dilute exhaust flow and a chemical balance of the fuel, intake air, and dilute exhaust as described in § 1065.655. For this option, the molar flow of dilution air is calculated by multiplying the dilute exhaust flow by the mole fraction of dilution gas to dilute exhaust,  $x_{\text{dil/exh}}$ , from the dilute chemical balance. This may be done by totaling continuous calculations or by using batch results. For example, to use batch results, the total flow of dilution air is calculated by multiplying the total flow of diluted exhaust,  $n_{\text{dexh}}$ , by the flow-weighted mean mole fraction of dilution air in diluted exhaust,  $\bar{x}_{\text{dil/exh}}$ . Calculate  $\bar{x}_{\text{dil/exh}}$  using flow-weighted mean concentrations of emissions in the chemical balance, as described in § 1065.655. The chemical balance in § 1065.655 assumes that your engine operates stoichiometrically, even if it is a lean-